10

Carrier WIDE AREA NETWORKS (WANs)

Last Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

First Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Directions

Place your cursor at the end of an answer part and hit Enter.

This will put you in the Answer style, which is indented and italicized.

If it does not, you can choose the Answer style.

# LANS and WANS (and MANS)

## LANs versus MANs and WANs

Test Your Understanding

1. a) Distinguish between LANs and WANs.

**b) What are rights of way**?

**c) What are carriers**?

d) Why do you have more flexibility with LAN service than with WAN service? Why?

2. **a) Why are typical WAN speeds slower than typical LAN speeds? Give a clear and complete argument**.

b) Why are future WAN prices difficult to predict?

**c) Compare the diversity of technologies in LANs and WANs**.

## Other Aspects of WANs

Test Your Understanding

3. a) Why do MANs have higher typical speeds than broader-scope WANs?

**b) Are LANs single networks or internets**?

**c) Are WANs single networks or internets**?

**d) Is the Internet a WAN**?

## ~~Carrier WAN Components and Business Uses~~

~~Test Your Understanding~~

~~4. a) List the three basic components of wide area networks.~~

~~b) Are access links wired or wireless?~~

~~c) What is CPE?~~

~~d) What are the two common business uses for carrier WANs?~~

~~e) Distinguish between the Internet and carrier WANs.~~

~~f) Why are carrier WANs not often used to link multiple firms together?~~

## The Telephone System

Test Your Understanding

5. **a) Why is the PSTN important in WAN data transmission**?

b) What is the local loop?

~~c) What class of switches are most end office switches?~~

~~d) What is the structure of the PSTN core?~~

# Residential Wired Internet Access

## Residential Asymmetric Digital Subscriber Line (ADSL) Service

Test Your Understanding

6. a) Does residential DSL offer simultaneous voice and data service?

**b) Why is asymmetric speed acceptable in residential ADSL service**?

**c) What is beneficial about transmitting data over 1-pair voice-grade UTP**?

**d) What equipment does the customer need in his or her home**?

~~e) What is the purpose of the DSLAM?~~

f) Why is FTTH attractive?

**g) How are carriers attempting to reduce the cost of installing FTTH**?

## Cable Modem Service

Test Your Understanding

7. a) What transmission media do cable television companies use?

~~b) Why is coaxial cable called “coaxial”?~~

c) Distinguish between the coaxial trunk cable and drop cable.

~~d) What types of amplifiers are needed for cable data service?~~

**e) What device do customers need for cable modem service**?

## ADSL versus Cable Modem Service

Test Your Understanding

8. **a) What are the important things to consider when deciding between ADSL and cable modem service for your residence**?

**b) In the past, how has ADSL compared to cable modem service**?

**c) Which of these two services are moving toward FTTH**?

# Cellular Data Service

## Cellular Service

Test Your Understanding

9. **a) In cellular technology, what is a cell**?

**b) What is a cellsite**?

c) What are the two functions of the MTSO?

~~d) In cellular system, distinguish between handoffs and roaming.~~

## Why Cells?

Test Your Understanding

10. **a) Why does cellular telephony use cells**?

**b) What is the benefit of channel reuse**?

## Cellular Data Speeds

Test Your Understanding

11. a) How fast can the best systems today download data?

b) What speed is on the horizon?

**c) What is today’s dominant cellular technology**?

d) What speed does the LTE Advanced standard currently require?

~~e) Why does the book not distinguish between 3G and 4G service?~~

**f) What factors affect what throughput an individual user will receive**?

# Wired Business WANs

## Leased Lines

Test Your Understanding

12. a) What are the characteristics of leased lines?

~~b) Distinguish between leased lines and access lines.~~

**c) What device must a customer have at its site to connect to a leased line**?

## Reaching the ISP via a Leased Line

Test Your Understanding

13. **When a customer uses a leased line to connect to its ISP, what two points does the leased line connect**?

## ~~Leased Line Private Corporate WANs~~

~~Test Your Understanding~~

~~14. a) If you need a speed of 1.2 Mbps between two points in the United States, what leased line would you specify in the United States and in Europe?~~

~~b) Repeat for 160 Mbps.~~

~~c) Repeat for 100 kbps.~~

~~d) Repeat for 3 Mbps.~~

~~e) Why do carriers offer low-speed “leased lines” that are really DSL lines?~~

~~f) How do business DSL lines differ from residential DSL lines?~~

~~g) Why is the need to manage the leased line network an issue?~~

## Public Switched Data Network (PSDN) Carrier WANs

Test Your Understanding

15. ~~a) If a firm has ten sites, how many leased lines will it need to use a PSDN?~~

~~b) Between what two points will a leased line run for PSDN access?~~

~~c) Which PSDN technology grew rapidly in the 1990s?~~

~~d) Which PSDN technology is growing rapidly today?~~

~~e) What organization is standardizing carrier Ethernet?~~

~~f) What is the former name for carrier Ethernet?~~

~~g) Distinguish between E-Line and E-LAN service.~~

~~h) For what reasons is CE attractive?~~

~~i) Is the 802.3 Working Group working with MEF?~~

## Multiprotocol Label Switching (MPLS)

Test Your Understanding

16. **a) In MPLS, is selecting the best interface for each packet at each router done when the packet enters the network or before**?

**b) Why is this beneficial**?

c) What is the name of the path selected for a particular conversation?

**d) When a source host first transmits to a destination host after a label switched path is established, what will happen**?

**e) Do label switching routers along the MPLS path look at the packet’s IP address? The answer is not explicitly in the text. Explain your reasoning**.

f**) On what basis does each label switched router base routing decisions**?

g) Why is MPLS transparent to the source and destination hosts?

**h) What are MPLS’s attractions**?

i) What is traffic engineering?

j) Can MPLS provide traffic load balancing?

**k) Is it possible to implement MPLS across the entire Internet? Explain**.

## ~~WAN Optimization~~

~~Test Your Understanding~~

~~17. a) Where are WAN optimization devices found?~~

~~b) List the four mechanisms we discussed for optimizing transmission over a transmission link.~~

~~c) How does compression reduce traffic?~~

~~d) How does caching reduce traffic?~~

~~e) Explain traffic shaping.~~

~~f) How does traffic shaping reduce traffic?~~

~~g) What is the main benefit of application and network protocol acceleration?~~

# ~~Software Defined Networking (SDN)~~

## ~~Concepts and Benefits~~

~~Test Your Understanding~~

~~18. a) What are the three layers in SDN?~~

~~b) Distinguish between forwarding and control.~~

~~c) Traditionally, where have these functions been located?~~

~~d) How does this change in SDN?~~

~~e) What pressing management issues does SDN address?~~

~~f) Why did SDN begin in large data centers?~~

~~g) What is the ability to change forwarding tables rapidly called?~~

~~h) How can SDN reduce OpEx~~

~~i) How can it reduce CapEx?~~

~~j) How can it facilitate radical changes in the network’s operation?~~

## ~~Forwarding Tables~~

~~Test Your Understanding~~

~~19. a) Was the information we presented about switching and routing tables in earlier chapters complete? Explain.~~

~~b) From where does an SDN switch or SDN router get its forwarding table rules?~~

~~c) Explain the rule in the first row. An Ethernet VLAN is used to segregate hosts. Hosts in a VLAN can only communicate with hosts on the same VLAN.~~

~~d) Explain the rule in the second row.~~

~~e) On what device is the forwarding table—a controller, switch, or router?~~

## ~~SDN Applications~~

~~Test Your Understanding~~

~~20. a) What good is a controller without SDN applications?~~

~~b) List the four application categories listed in the text.~~

## ~~APIs~~

~~Test Your Understanding~~

~~21. a) What is an API?~~

~~b) For SDN, distinguish between northbound and southbound APIs.~~

~~c) What is OpenFlow, and why is it significant?~~

~~d) Is OpenFlow a northbound or southbound API?~~

~~e) What threat does OpenFlow create for switch and router vendors?~~

~~f) How are vendors responding?~~

## Added Questions

22. a) Compare the advantages and disadvantages of Internet transmission and MPLS for corporate WANs.

**b) What is a hybrid WAN**?

c) Why is it difficult to achieve?

**d) Why may a company not be able to implement a complete MPLS corporate WAN**?

# Conclusion

## Synopsis

## End-of-Chapter Questions

~~Thought Questions~~

~~10-1. Distinguish between dial-up telephone service you use as a consumer and leased line services used in business. (You will have to extrapolate from your own experience with dial-up lines.)~~

~~10-2. If you have a network of leased lines, you have options for how many sites you connect. Sites can communicate directly or through intermediate sites. a) In a full mesh, every pair of sites will be directly linked by a leased line. If there are N sites, there will be N\*(N-1)/2 connections. In Figure 10-13, how many leased lines would be used in a full mesh?~~

~~b) In a hub-and-spoke network, there is a central site, and a leased line radiates from it to each other site. In Figure 10-13, how many leased lines would be used in a hub-and-spoke network with the hub located at Site A?~~

~~c) What is the benefit of full mesh networks over hub and spoke networks?~~

~~d) What is the advantage of hub and spoke networks over full mesh networks?~~

~~e) How would you use this information about advantages to advise a company about what to do when it installs a network of leased lines?~~

~~10-3. In ADSL service, there is a single UTP pair running from the end office switch to the individual household. In cable modem service, the thick coaxial cable in the neighborhood is shared by many subscribers. Yet typically, cable modem service provides faster service to individual customers than ADSL. How can this be? Hint: Draw a picture of the entire situation for both ADSL and cable modem service.~~

~~10-4. a) What wired WAN technologies are growing?~~

~~b) Why will leased lines continue to be important even if networks of leased lines are no longer used?~~

Hands-On

10-5. If you have a smartphone, download an app to tell your data transmission throughput. What did you find?

Perspective Questions

10-6. What was the most surprising thing in this chapter for you?

10-7. What was the most difficult part of this chapter for you?